OIPE JC38
DEC 0 9 2004
PATENT & TRADEMARK OFFICE

U.S. Patent Application Serial No. 09/980,157
MARKED UP COPY

OIPE JC88
DEC 0 9 2004
PATENT & TRADEMARK OFFICE

IPC- 7 G01C21/00
G01C21/24
G01S3/789

# ~~A~~ System for lighting of an object

[Technical Field]

The invention ~~deals with~~ relates to navigational engineering, more specifically, to opto- ~~optical-~~ electronic systems for autotracking of moving objects.

[Background Art]

Known in the present state of art ~~There~~ are systems for automatic guidance and tracking of moving targets, which are based on the frequency, phase, pulse-height, time-pulse and amplitude-phase principles and can be used for illumination of objects [1].

Known coordinators (target seekers) generate signals, which are proportional to the constituents of the angle of misalignment in two mutually perpendicular planes of control. These signals go to the monitoring drive of the system for target autotracking, which keeps the coordinator's optical system operating in a mode to have the optic axis constantly directed towards a target.

~~One of the reasons that prevent from obtaining the undermentioned technical result by the known device is the fact that~~ Insofar as modulation of the radiant flux is performed mechanically with the ~~help~~ aid of a modulating disk which is disposed in the focal plane of a lens and rotated by an electric motor ~~with~~ at a constant speed, the known system fails to provide high accuracy of measuring angular coordinates of the target.

There also exists a two-gimbal suspension with a diverting mirror for a precision optical tracking system developed by the TRW firm and intended to be used as part of an optical tracking system [2].

This device consists of a gimbal joint of flexible suspension, four electrodynamic drives, a caging gear, a device of signal ~~levelling~~ leveling for integration with a capacitive pickup of the shift, and an electronic unit. A capacitive sensor serves for generating signals of angular misalignment along two axes.

On both sides of the outer gimbal ring there are two actuators of the detention system.

Mobile electromechanical clusters cause low reliability and low-speed response of the above-mentioned coordinators.

Besides, their construction does not allow directing mirror-reflected beams along their optic axes and, moreover, these target seekers are capable of tracing targets only within the immediate field of their vision and stop operating when the target is not seen, for they are not designed for operating in the search mode.

The closest ~~nearest~~ device (the prototype) of the proposed invention as to a combination of features is a device ~~same intent as the presentational invention in what concerns the complex of its characteristics is a system~~ for location of two-dimensional coordinates of an object (a target seeker) [3]. The prototype has the first and ~~the~~ second ruled optoelectronic ~~optical-electronic~~ converters ~~(OEC)~~ with the image-transforming optics; the inputs of these converters are connected to the output of the synchro generator, while their outputs, to the inputs of the corresponding search signal detectors (threshold elements).

The ruled optoelectronic converters ~~OECs~~ are mutually perpendicular, so that rotation axes of the objects should pass through optical centers ~~centres~~ of the cylinder lenses. ~~L1 and L2~~.

On mutual lag (misalignment) of the strobe pulse and the target signal, control signal conditioners ~~CSC1 and CSC2~~ produce control signals, whose signs and values are proportional to the angular coordinates of the target in two mutually perpendicular planes of control.

Yet, the known optoelectronic ~~optical-electronic~~ target seeker fails ~~does not permit~~ to point the beam at an object and seek for a target if the object is beyond its field of vision.

[Summary of the Invention]

The present ~~purpose of the presentational~~ invention has for its object to provide a system for lighting an object, said system ensuring a higher measuring accuracy of the angular coordinates of a target due to beam pointing at the center of the target image. One more object of the invention is to extend the functional capabilities of the system ~~consists in diversifying functions of a target seeker~~ by enabling it to search for a ground target and to light it from the outer space.

The aforesaid objects ~~implementation~~ of this invention are accomplished due to the fact that the system for lighting an object comprising a first guidance device further comprises a ~~will technically result in more precise measuring of angular coordinates of a target because now the beam is pointed at the centre of the target image.~~

~~This technical result is achieved with the help of such elements installed in the first device of the object guidance, as the additional~~ second guidance device

optically connected ~~with~~ to the source of radiation, the first and the second subtracting ~~amplifier~~ amplifieres, the first and the second ~~actuator~~ actuators, and a mirror. The first outputs of the first and ~~the~~ second guidance devices are connected to the corresponding inputs of the first subtracting amplifier, while their second outputs, / to the corresponding inputs of the second subtracting amplifier. The outputs of the first and ~~the~~ second subtracting amplifier are connected to the inputs of the corresponding actuators kinematically ~~linked~~ coupled to the mirror.

The first and the third guidance devices are of identical circuit design and actuate ~~electrically linked to each other~~ the target seeker ~~(TS)~~, the search signal conditioner ~~(SSC)~~, the first and the second angular position pickups, ~~($APP_1$, $APP_2$)~~, commutators, the third and the fourth actuators, ~~($A_3$, $A_4$)~~, ~~kinematically~~ cinematically linked ~~with~~ to a target seeker, and the angular position pickups, all other being electrically connected to one another.

[Brief Description of the Drawings]

Further objects and advantages of the present invention will become obvious from a detailed description of the system for lighting an object and the accompanying drawings, wherein:

Figure 1 ~~shows the~~ is a block diagram of the lighting system, ~~where~~: according to the invention;

~~1 - object~~;

~~2 - radiation source~~;

~~3, 4 - (1, 2 respectively) guidance device~~;

~~5, 6 - (1, 2 respectively) subtracting amplifier~~;

~~7, 8 - (1, 2 respectively) actuators~~;

~~9 - the first mirror~~;

~~ñ - normal to the surface of the mirror 9 in the origin of the coordinate~~ system OXYZ;

~~9' - the second mirror~~;

~~10 - commutation unit~~;

~~11, 12 - (3, 4 respectively) actuato~~rs;

~~13 - the third guidance device ($GD_3$~~);

~~14 - laser excitation cir~~cuit.

Figure 2 ~~shows the~~ is a functional diagram of the commutation unit ~~(CU10)~~ ~~where~~:

~~15, 16 - (1, 2 respectively) commutators~~;

~~17 - the first radio receiver with an aerial (Ar)~~;

~~18 - three-contact four-position radio-controlled switch~~;

~~19 - source of unit voltage $+V_1$~~;

~~20 - the first "$I_1$" element~~;

~~21 - the first inverter~~;

~~22 - radio transmitter~~;

~~$V_{inp1}$, $V_{outp2}$ - the first and the second output~~;

~~$V_3$, $V_4$, $V_3^{I}$, $V_4^{II}$ - the third - sixth input~~;

~~$A_1$, $A_2$, $A_3$, $A_4$ $+V_1$ - the first-fifth respective commutation unit output~~.

Figure 3 ~~shows the~~ is a block diagram of the ~~first (third)~~ two guidance devices (3,13); ~~where:~~

~~$23^1$ - the first (third) target seeker $TS_1$~~;

~~24 - the first (third) light marker (corner-reflector) $LM_1^{1}$ ($LM_1^{111}$)~~;

~~25, 26 - (5,6 respectively) actuators $A_5^{1}$, $A_6^{1}$, $A_5^{111}$, $A_6^{111}$)~~;

~~27, 28 - (1, 2 respectively) angular position pickups~~;

~~29, 30 - (3, 4 respectively) commutators ($C_3^{1}$, $C_4^{1}$, $C_3^{111}$, $C_4^{111}$)~~;

~~31 - the first (third) search signal conditioner (SSC)~~.

Figure 4 ~~shows the~~ is a block diagram of the ~~second~~ third guidance device used in the system; ~~$GD_2$ 4~~, where:

~~32 - the second target seeker $TS_2$~~;

~~33 - the second light marker $LM_2$ (the second corner-reflector $CR_2$)~~;

~~34, 35 - (7, 8 respectively) actuators ($A_7$, $A_8$)~~;

~~36, 37 - (3, 4 respectively) angular position pickups ($APP_3$, $APP_4$)~~;

~~38, 39, 40, 41, 42, 43, 44 (5, 6, 7, 8, 9, 10, 11 respectively) - commutators~~;

~~45 - the second search signal conditioner ($SSC_2$)~~;

~~46 - commutation input of the second guidance device ($GD_2$)~~.

Figure 5 ~~shows the~~ is a pulse laser excitation circuit ~~14, where~~:

~~47 - the second radio receiver~~;

~~48 - remote radio-controlled switch~~;

~~49 - the second source of unit voltage $+V_2$~~;

~~50 - the excitation circuit outp~~ut;

~~51 - the second "$I_2$" elem~~ent;

~~52 - the second inverter ($HE_2$)~~;

~~53 - the third "$I_3$" element.~~

Figure 6 shows the construction of one of the mirrors; ~~the second film mirror $9^1$, where:~~

~~54 - locating ring with limiters~~;

~~55~~ - internal ~~pneumatic chamber consisting of 2 sections~~;

~~56~~ - external ~~pneumatic chamber~~;

~~57 - radial tubes (h~~oses);

~~58~~ - the first ~~elastic reflecting sheet;~~

~~59 - dielectric film~~;

~~60 - metal layer;~~

~~61 - source of compressed gas (SCG);~~

~~62~~ - the second ~~elastic reflecting sheet~~;

~~63~~ - source ~~of vacuum (pump)~~;

~~64 - emf source;~~

~~65 - isolated rings~~;

~~66~~ - sources of ~~controlled voltage;~~

~~67 - corrugated elastic band~~;

~~68~~ - the third ~~pneumatic chamber;~~

~~69 - hose (gas conduit)~~;

~~70 - clamp-shaped spring;~~

~~71~~ - valves.

- Detailed Description -

- Insert paragraphs A & B attached

Figure 7 ~~shows~~ presents combined kinematic and optical ~~schemes~~ diagrams of the system; ~~in which the first target seeker ($TS_1$)$23^1$ of the first guidance device $GD_1$3 makes the search of an object 1 with the help of the first 72 and the second 73 bracket of the actuators $A_5$ and $A_6$ (servomotors $25^1$, $26^1$), whose angular positions are determined by angular position pickups ($APP^1$ and $APP^2$) (synchro transmitters or~~

INSERT A

Detailed Description of the Invention

The system for lighting an object 1 (FIG.1) comprises a radiation source 2 and guidance devices 3, 4, 5, of which the guidance device 3 is optically connected to the object 1, and the device 4, to the radiation source 2. The system further comprises a subtracting amplifier 6 having its inputs 7 and 8 connected to the respective outputs of the guidance devices 3 and 4, while the output thereof is connected to an input 9 of the commutation unit 10, and a subtracting amplifier 11 whose inputs 12 and 5 are connected to the outputs the guidance devices 3 and 4, respectively, and its output is connected to an input 14 of the commutation unit 10. Inputs 15 and 16 of the commutation unit 10 are connected to the corresponding outputs of the guidance device 3, while its inputs 17 and 18 thereof are connected to the respective outputs of the guidance device 4. In addition, the system comprises a mirror 19 with which kinematically coupled are actuators 20 having their inputs connected to an output 23 of the commutation unit 10, as well as a mirror 19 with which kinematically coupled are actuators 46 connected to an output 47 of the commutation unit 10 and actuators 48 having their input connected to an output 49 of commutation unit 10. An output 51 of commutation unit 10 is connected to the input of the guidance device 4. The radiation source 2 is a laser disposed on guidance device 5 and connected to a laser excitation circuit 52 whose input

are connected to the respective outputs of the guidance device 5.

The commutation unit 10 comprises commutators 31 and 53 (FIG.2) having one of the inputs thereof serving as respective inputs 15, 47, 9, and 14 of commutation unit 10, a radio receiver 33 with an antenna A, said receiver being connected to three contacts 55, 56, and 36 of a four-position radio-controlled switch 37 through which an output 21 and the output 47 of the commutation unit 10 are connected to the output of the commutator 31, and the output 23 and an output 49 of the commutation unit 10 are connected to the output of the commutator 53. The commutation unit 10 comprises also a unit signal source 59 whose output being connected, when the contacts 55, 56, 36 of the switch 37 in position IV, to the output 51 of the commutation unit 10, and when the switch in position III, to parallel-connected inputs 60 and 61 of the respective commutators 31 and 53. In addition, the contacts 56 and 36 of the contacts 55, 56, 36 of the switch 37 with its being in positions II, III, and IV are parallel-connected. The commutation unit 10 further comprises an AND gate 62 having its inputs connected to the inputs 9, 14, 15, 16, 17, and 18 of the commutation unit 10, and its output connected, through an inverter 63, to a radio transmitter 64.

FIG.3 presents a block-diagram of the guidance device 3 or 5, each comprising kinematically coupled a target seeker 44 carrying

a light marker 66 (or corner reflector), actuators 46 and 47, and angular position pickups 48 and 49 whose outputs are in fact the respective outputs of the guidance device 3 or 5. The pickups 48 and 49 may appear as, e.g., synchro transmitters or potentiometers. Furthermore, each guidance device 3 or 5 comprises a search signal conditioner 50 connected respectively through its outputs to the outputs of the target seeker 44, one of said outputs serving as respective outputs of the guidance device 3 or 5. One of the outputs of the search signal conditioner 50 is connected to one of the inputs of a commutator 60, its second output, to one of the inputs of a commutator 61, and a third output of the search signal conditioner 50 is connected to the parallel-connected other inputs of the commutators 60 and 61 whose outputs are connected to the inputs of the actuators 46 and 47. Besides, one of the inputs of the commutators 60 and 61 are connected to respective outputs of the target seeker 44.

The guidance device 4 (FIG.4) comprises kinematically coupled a target seeker 53 carrying a light marker 54 (or corner reflector), actuators 55 and 56, and angular position pickups 57 and 58 whose outputs are in fact the respective outputs of the guidance device 4, as well as commutators 59, 60, 61, 62, 63, 64, and 44 and a search signal conditioner 66. One inputs of the commutators 59, 60, and 61 are connected to the corresponding outputs of the target seeker 53, while the other inputs of said

commutators are parallel-connected to the corresponding inputs of the commutators 64 and 44 and serve in fact as the commutation input of the guidance device 4. In addition, the outputs of the commutators 59, 60, and 61 are connected respectively to the inputs of the search signal conditioner 66 two outputs of which are connected to the corresponding inputs of said commutators, and a third output thereof is connected to the parallel-connected inputs of said commutators 62 and 63. Other inputs of the commutators 62 and 63 are connected to the outputs of the commutators 64 and 44 whose inputs are connected respectively to the outputs of the target seeker 53.

FIG.5 displays a pulsed laser excitation circuit, comprising a radio receiver 67 with an antenna, a remotely controlled switch 68 connected to the output of a unit signal source 69, as well as series-connected AND gate 70, NOT (inverter) gate 71, and an AND gate 109. One of the inputs of the AND gate 109 is connected, via the switch 68, to the output of the unit signal source 69, while the output of the AND gate 109 is in fact the output of the laser excitation circuit 52 (FIG.1). Besides, the inputs of the AND gate 70 (FIG.5) are in effect the inputs of the laser excitation circuit 52 (FIG.1) connected to the outputs of the guidance device 5.

The film mirror 19 (FIG.6) comprises a locating ring 110 with limiters, an internal pneumatic chamber 74 and external pneumatic

chamber 75 communicating with each other through radial tubes 76 appearing as, e.g., hoses, as well as with a source 77 of compressed gas through a gas conduit 78 appearing as, e.g., a hose wherein a valve 79 is provided. The pneumatic chambers 74 and 75 and radial tubes 76 are associated with an elastic reflecting sheet 106 consisting of an elastic dielectric film 107 to which a light-reflecting metallic (e.g., aluminum) layer 109 is applied.

The film mirror 19 may further comprise an elastic reflecting sheet 110 which is positioned at a specified distance from the reflecting sheet 106, while the metallic layers of the sheets 106 and 110 are connected to the opposite poles of an emf source 111. The reflecting sheets 106 and 110 together with the pneumatic chambers 74 and 75 establish a pressure-tight low-pressure cavity communicating with a source 112 of vacuum.

Furthermore, the internal pneumatic chamber 74 may made up of two pneumatically intercommunicating sections interconnected by a corrugated band so as to be mutually displaceable, and the metallic layer of the reflecting sheet 110 may appear as concentric rings 87 insulated from each other and connected to sources 108 of controlled voltage. A spring shaped as a clamp 89 is put from above onto the corrugated band 86, and a pneumatic chamber 90 is placed in the interior space of said spring and communicating, via an individual gas conduit 91, to the source 77 of compressed gas.

FIG.7 presents combined kinematic and optical diagrams of the system, wherein the target seeker 44 of the guidance device 3 makes the search of an object 1 with the aid of brackets 109 and 110 of the actuators (servomotors) 46 and 47 whose angular positions are determined by the angular position pickups (synchro transmitters or potentiometers) 48 and 49. The target seeker 53 is directed towards the source of radiation (the Sun) by brackets 94 and 95 mechanically associated with the respective shafts of the actuators (servomotors) 55 and 56 whose angular positions are determined by the angular position pickups of the guidance device 4.

The mirror 19 is installed on an internal frame 96 of a first gimbal mount whose external frame 97 is kinematically coupled to the actuators 22.

The mirror 19 is installed on a second gimbal mount composed of an internal frame 98 and an external frame 99, respectively, and is held in position on the ring 110 which in turn is locked-in with the external frame 99 of the second gimbal mount whose position with respect to the internal frame is adjustable with the aid the actuators (servomotor) 46. The internal frame 98 is adjustable for position with respect to the gyro-stabilized platform with the aid of the actuators 48.

FIG.8 shows various positions of the mirror 19 (j1 - j2) rotating about its own axis, relative to the Earth 100.

The search signal conditioner 50 or 66 (FIG.9) comprises a logic element (gate) 101 whose inputs 102, 103, and 104 serve as the inputs of the search signal conditioner 50 or 66, of which the input 104 is a sync input. The search signal conditioner 50 or 66 further comprises a generator 105 of linearly varying voltage, said generator having its zeroing input connected to the output of the logical unit 101 and its output, to the parallel-connected control inputs of amplitude modulators 106 and 107 whose other inputs are connected to the respective outputs of a quadrature generator 108 and the outputs of said modulators are connected respectively to one inputs of summers 109 and 110 the other inputs of which are connected to the respective outputs of sampling-and-storage devices 111 and 112 whose data inputs are connected to the outputs of the summers 109, 110 which are also connected to the inputs of analog-to-digital converters 15 and 114, respectively. The record permitting inputs of the sampling-and-storage devices 111 and 112 are connected in parallel to each other and also connected to the output of the logical unit 101. The outputs of the analog-to-digital converters 15 and 114 and the output of the logical unit 101 are in fact the respective outputs of the search signal conditioner 50 or 66.

FIG.10 displays a functional diagram of the logical unit 101 which comprises inverters 115 and 116 whose outputs are connected to the respective sync set inputs of flip-flops 117 and 118 having their outputs connected to the D-inputs of flip-flops 119 and 120. The C-inputs of the flip-flops 117 and 118 are integrated and connected to the output of an inverter 121 whose input is connected to the C-inputs of the flip-flops 117 and 118. The logical unit 101 further comprises an AND gate 122 connected through its inputs respectively to the outputs of the flip-flops 119 and 120, the output of said AND gate 122 is also the output of the logical unit 101. The inputs of the inverters 115 and 116 are the respective inputs of the logical unit 101, and the input of the inverter 116 is in fact the sync input thereof.

potentiometers) 27' and 28'. The second target seeker $23^{II}$ of the second guidance device is directed towards the source of radiation (the Sun) by the third 74 and the fourth 75 bracket, mechanically attached to the corresponding shafts of the actuators $A_7$34 and $A_8$35 (servomotors), whose angular positions are determined with the help of the third ($APP_3$ 36) and the fourth ($APP_4$ 37) angular position pickup of the second guidance device 4.

The second mirror $9^I$ is established on the gimbal mount, which consists of an internal 76 and external 77 frame.

The second mirror $9^I$ is rigidly fixed on the ring 54, which, in its turn, is rigidly attached to the external frame of the gimbal mount 77, whose position with respect to the internal frame 76 is changed with the help of the third actuators $A_3$ (the servomotor) 11. Position of the internal frame 76 with respect to a gyro-stabilised platform is changed with the help of the fourth actuators $A_4$ 12.

Figure 8 shows different positions of the mirror $(11_1 \div 11_6)$ ~~$(\varphi_1 \div \varphi_6)$~~ ~~rotating~~ about its axis in relation to the Earth ~~78.~~;

Figure 9 is a ~~shows the~~ functional flow chart of the searching signals conditioners; and ($SSC_1$ 31, $SSC_2$ 65), where 79 is a generator of linearly changing voltage (GLCV), whose output is connected to the controlling inputs of the first 80 and the second 81 amplitude modulator ($M_1$, $M_2$). The modulators' outputs are connected to the first inputs respectively of the first 82 and the second 83 summer ($E_1$, $E_2$). The second inputs of the summers, in their turn, are connected to the outputs respectively of the first 84 and the second 85 storage sampling device ($SSD_1$, $SSD_2$), while their outputs – to the inputs respectively of the first 86 and the second 87 analogue-digital converter ($ADC_1$, $ADC_2$). 88 is a quadrature generator (G); 89 - a logical unit (LU), the inputs of which are respectively the first 90, the second 91 and the sync input 92 of the search signal conditioner $SSC_1$31, $SSC_2$45, while 93 and 94 are respectively its first and second output.

Figure 10 is a ~~gives the~~ functional diagram of the logical unit ~~89, where 90, 91,~~ and 92 are the first, the second and the sync input, 95 and 96 - the first and the

~~second inverter ($HE_3$, $HE_4$), whose outputs are connected respectively to the setting to unity sync inputs of the first 97 and the second 98 flip-flop, with their outputs connected to the D-inputs of the corresponding third 99 and fourth 100 flip-flop; their outputs, in turn, are connected to the inputs of the fourth "I" element 101; C-inputs of the first two flip-flops ($FF_1$, $FF_2$) are paralleled and connected to the output of the fourth inverter 102. The fourth "I" 101 element's output is the output 103 of the logical unit 89.~~ [SEE INSERT A attached] - Entitled "Detailed Description of the Invention"

The system for lighting of an object operates as follows.

For illumination of cities situated in the area of middle latitudes and at the equator, the system for illumination should be installed on a gyrostabilized ~~gyrostabilised~~ platform placed in a stationary orbit with an altitude about 36,000 km. Fixity of the satellite, which is carrying the system of the mirror guidance, in relation to the ground object adds to the advantages of the project.

High altitude of the stationary orbit permits to light a number of selected ground objects with the aid ~~help~~ of a single system.

From a satellite in the stationary orbit a vast area of the Earth can be seen that extends for $\pm 60^0$ from the west to the east and for $\pm 70^0$ from the north to the south.

Emergency illumination of objects in case of natural disasters and catastrophes is secured by three systems, which are removed from each other for $120^0$ along the equator and completely embrace the Earth surface, except for the polar areas.

A satellite in the stationary orbit is almost constantly illuminated by the Sun. Its stay in the Earth shadow takes not more than 1% of the earth-rotation period, which determines high potency of the system.

While tracking, the mirror turns through 66 ~~$45^0$~~ in 6 hours, that is, it rotates at the angular velocity of $\varphi' = 7.5$ '/min (minutes of arc per minute).

The whole system can be supplied with power by solar batteries, which are permanently directed towards the Sun by the second guidance device ~~$GD_2$~~ 4 (FIG.1).

Directing sensors usually consist of two sensing elements, electrically linked into a bridge circuit. Together with them, the system of solar orientation includes an all-round looking sensor to produce information to a low degree of accuracy sufficient for more precise sensors of the guiding device 4 to direct their fields of vision towards the Sun.

The system for lighting of an object is established on a gyrostabilized ~~gyrostabilised~~ platform of a space vehicle ~~(SV)~~. Every problem of the spacevehicle ~~SV~~ flight control is handled by the control system. Together with the problem of a spacevehicle ~~an SV~~ attitude-control and stabilization ~~stabilisation~~, it is guidance of the guidance devices 3 and 4 ~~$GD_1$ and $GD_2$~~ towards different objects in response to a command from the Earth.

Signals, qualifying physical parameters of the flight, are received from the system of sensors.

Sensors of direction are used for attitude control. Stabilization ~~Stabilisation~~ of the spacevehicle ~~SV~~ is performed by signals from the sensors of direction and by signals of gyroscopic pickups, which register position of the axes in space.

Reference parameters of the spacevehicle ~~SV~~ flight can be loaded into the storage of an onboard computer, transmitted aboard by the ground stations through a command radio line or withdrawn from the pickups of the gyro stabilized ~~stabilised~~ platform.

Comparison of actual flight parameters with the reference ones, detection of error signals and generating of correcting control signals are performed by an onboard computer.

The ~~second~~ mirror 19 ~~9~~ is rotated about two orthogonally related axes OX and OY with the aid ~~help~~ of the actuators 46 ~~$A_3$ 11~~ and 48 ~~$A_4$ 12~~. A change in the attitude of the locating ring 110 ~~54~~ is followed by the change in the attitude of the ~~second~~ mirror 19. The external frame 99 of the second ring-shaped gimbal mount ~~77~~ is fitted ~~fit~~ with the locating ring 110 with limiters ~~54~~ and the internal pneumatic chamber 74 ~~55~~. This chamber is pneumatically connected by radial tubes (hoses) 76 ~~57~~ to ~~with~~ the concentric external pneumatic chamber 75 ~~56~~ and together with it makes a single pressure-tight cavity, which is jointed up to a source 77 of compressed gas ~~(SCG) 61~~. In transit, the chamber is empty

and may be folded. Gas delivery will make the chamber take the form of a wheel. The external ring ~~56~~ of the pneumatic chamber 75 can be a few tens of kilometres in radius. In advance, when still on the ground, the reflecting sheet ~~58~~ 106 is attached to the pneumatic chambers ~~55~~ 74, ~~56~~ 75. With gas delivery from the source ~~SCG 61~~ 77, the external ring ~~56~~ of the pneumatic chamber starts pulling the ~~first~~ reflecting sheet ~~58~~ 106. The pneumatic chambers finally having taken the form of the wheel, the reflecting sheet ~~58~~ 106 should take the form of a plane.

For attainment of strength, the sheet can have a kapron warp coated with ~~a~~ the dielectric film 107 (e.g., ~~fluorine~~ fluorinated plastic), ~~on~~ to which a reflecting metal coating ~~60~~ 109 (e.g., aluminium) is applied.

When filled with gas, the collapsible ~~radical~~ radial hoses ~~57~~ 76 take the form of tubes. They, to some extent, reinforce the pneumatic wheel ~~(see Fig. 6~~). This is how the ~~second~~ mirror ~~9~~ 19 is constructed. With the ~~help~~ aid of the ~~third 11 and the fourth 12~~ 46 and 48 actuators the ~~second~~ mirror ~~9~~ 19 is rotated about the axes OX and OY to direct the reflected sunrays towards a ground object.

Because the solar disk has ~~a Ψ~~ an angle of view equal to Ψ, sunrays ~~rays~~ reflected by the mirror ~~9~~ 19 diverge and illuminate the ground area considerably exceeding that of the mirror.

The ~~second~~ mirror ~~9~~ 19 may be given a spherical (concave) form. This allows one to concentrate sunrays on a small area and, thus, to increase the illuminance. For the purposes of ~~defence~~ defense, the focused sunrays can be used for setting fire to the enemy's ground objects. For peaceful purposes, energy of radiation can be transformed into electrical energy with the ~~help~~ aid of solar batteries. If necessary, a spot beam following a spiral or any other prescribed trajectory, which depends on the voltage values generated by the quadrature generator ~~45~~ 108 (Fig. ~~6~~ 9), can intensify illumination of the surface like a floodlight.

To obtain a spherical specular surface ~~(see Fig.6)~~, in addition to the ~~first~~ reflecting sheet ~~58~~ 106 (FIG. 6), the ~~the second~~ reflecting sheet ~~62~~ 110 is used. Both reflecting sheets ~~58~~ 106 and ~~62~~ 110 are attached only to the pneumatic chambers ~~55~~ 74, ~~56. They~~ 75 and are not joined to the radial tubes 76. The internal pneumatic chamber 74 ~~55~~ and external ~~56~~ pneumatic chamber~~s~~ 75 together with the reflecting sheets ~~58~~ 106, ~~62~~ 110 make a hermetically sealed chamber, which is joined to the source of

vacuum (vacuum pump) 112 ~~63~~. Pressure created by the source of vacuum 112 between the reflecting sheets in the chamber is lower, than that in the ambient outer space. It is due ~~Due~~ to an excess ~~exuberant~~ external pressure that the specular sheets are attracted to each other and their surface receives a ~~the~~ spherical form. The sag value *h* can be calculated beforehand and taken into account when fixing the sheets to the internal pneumatic chamber 74 ~~55~~. The inner edges of the sheets are brought together relative to the plane for a distance of 2h. If necessary, this spacing interval can also be changed within 0–2h ~~0÷2h~~ by a ~~remote~~ command from the Earth.

Electrostatic forces can be used to obtain a spherical specular surface and for remote modification of its radius of curvature.

For this purpose, the metal platings of the reflecting sheets 106 ~~58~~, 110 ~~62~~ are connected to the ~~emf~~ source 111 of emf (or voltage) ~~63~~. By varying the voltage, it is possible to control the force of electrostatic attraction of the sheets, and by this to perform remote focusing of the spherical ~~9~~ mirror 19 and to control concentration ~~focusing~~ of the luminous flux.

To create a spherical mirror, electrostatic forces and excess ~~excessive~~ external pressure can be simultaneously applied as well.

Employment of both specular surfaces is also possible, for which it is necessary to turn them through 1106° ~~180°~~.

In order that a flat mirror could be transformed into a spherical one, the internal pneumatic chamber 74 ~~55~~ should be made of two sections pneumatically attached to each other by the ~~a~~ corrugated elastic band 86 ~~67~~. The ~~third~~ pneumatic chamber 90 ~~68~~ joined to the source 77 of compressed gas ~~61~~ by a separate gas conduit ~~line~~ (hose) 91 ~~69~~ is installed inside this corrugated band 86. By varying pressure in the ~~third~~ pneumatic chamber 90 one ~~we~~ can remotely change the interval between two sections of the internal pneumatic chamber within the limits of from 0 to 2h. This is how the sag of the ~~second mirror~~'s spherical surface of the mirror 19 and the radius of its curvature are changed.

~~At Fig. 5~~ The corrugated band 86 is topped with a clamp ~~yoke~~-shaped spring 89 ~~70~~, but it is possible that ~~for~~ the band itself be springy ~~to work as a spring.~~

In the normal ~~position~~ Conditions, both sections of the internal chamber 74 are pressed ~~to~~ against each other. With the start of gas delivery into the ~~third~~ pneumatic chamber ~~68~~ 90 inserted into the corrugated elastic band ~~67~~ 86, the sections of the internal pneumatic chamber ~~55~~ 74 move apart. At 9 definite pressure specular sheets ~~58~~ 106, ~~62~~ 110 take the form of a plane. To prevent ~~from~~ the sections of the chamber 74 from further moving apart, ~~further recession, there must be limiters fixed on both sides. A~~ the locating ring 110 is provided with the ~~with~~ end arresters ~~54 serves~~ serving this purpose.

To give the specular surface of the sheet a regular spherical form, the ~~second~~ metal coating applied ~~on~~ to the ~~second~~ reflecting sheet ~~62~~ 110 has the form of concentric rings ~~55~~ 87. Each ring has an electrical ~~outlet~~ terminal of its own soldered to ~~the~~ 9 metal bed.

By selecting the quantity, bandwidth and voltage applied to each ring, as well as the pressure in the third pneumatic chamber ~~68~~ 90, we can create specular surfaces of any configuration and curvature.

Depending on the problem to be decided, the ~~on-board~~ onboard computer by the ground command will change the voltage Vi on the rings ~~65~~ 87 and the pressure in the pneumatic chamber ~~68~~ 90.

For more effective employment of the system, in the daytime the ~~second~~ large-size mirror 19 can be used for a radio, television and telephone communication between ground objects. The mirror is used as a passive reflector. It is automatically established in the position that the normal ñ to the ~~centre~~ center of the mirror should coincide with the "mirror - radio beacon" direction. In this case, the maximum of the directivity lobe of the transmitting antenna is pointed at the mirror. The system works more effectively if the transmitter has a narrow directivity lobe, as that for laser-beam communication. Radiation of the transmitter falls on the mirror and, having been reflected by it, returns to the Earth. Owing to angular divergence of the transmitter's radiation, radiation reflected by the mirror covers a greater area. With a corner reflector placed in front of the target seeker ~~$TS_1$~~ 23 (FIG. 3) and the transmitter installed on a satellite-tracking platform of the type of the guidance device 5, the beam can be confined to several minutes of arc. Thus, the system can be used for laser beam communication between two ground objects, for which the ~~second~~ target seeker ~~$TS_2$~~ 53 (FIG. 4) must keep

tracking the second ground object. To achieve this purpose, the ~~second~~ seeker ~~$TS_2$~~ 53 in addition to an optical sensor is equipped with ~~by~~ radio-frequency range sensors designed similarly to those of the ~~first~~ seeker ~~$TS_1$~~ 44.

In order to establish a directional two-way laser beam communication between two ground objects, both transmitters should be installed on tracking platforms, with their radiation directed towards comer ~~corner~~ reflectors placed in front of the corresponding target seekers 44; ~~$TS_1$~~ and 53 ~~$TS_2$~~. Within the frequency range the transmitters should operate at different frequencies to exclude interference.

Changing between operational modes of the system is done in response to the ground commands delivered through a radio circuit. For this, the system is equipped with a commutation unit 10(FIG.1) ~~CU~~, with the aid ~~help~~ of which the system is placed in one of four operational modes:

a) directing the laser beam towards a target with the aid ~~help~~ of the ~~first~~ mirror 19 (~~the~~ I ~~I~~ position of the contacts 55, 56, 36 of the switch ~~18~~ 37);

b) one- or two-way communication between two ground objects with the aid ~~help~~ of the mirror 19 ~~9'~~ (~~the II~~ II position of the contacts 55, 56, 36 of the switch 37);

c) illumination of a ground object by radiation of its own transmitter (the III position) reflected by the mirror ~~9'~~ 19;

d) illumination of a ground object by the solar radiation with the aid ~~help~~ of the ~~second~~ mirror 19 ~~9'~~ (~~the IV~~ IV position of the contacts 55, 56, 36 of switch 37).

For exploiting the system in the "a" mode, a radio beacon should be placed at ~~in~~ the center ~~centre~~ of a lighted ground object (e.g., a city). To reduce power of the radio beacon, the latter can be installed on a guidance device designed as guidance device 3 ~~$GD_1$ 3~~ (see Fig.3).

The ~~first~~ guidance device 3 ~~$GD_1$ 3~~ is tracking the radio beacon ~~1'~~, while the ~~second~~ guidance device ~~$GD_2$~~ 4 is intended for tracking the solar disk.

These guidance devices 3 and 4 (~~see~~ Fig.3) permanently keep the radio beacon and the center ~~centre~~ of the solar disk on the optic axes of the corresponding target seekers 44 ~~$TS_1$~~ and 53 ~~$TS_2$~~.

Two signals, proportional to the target angular coordinates ~~of the target~~ $\Delta V_{\alpha}$ and $\Delta V_{\beta}$ in two planes of control are shaped at the outputs of the guidance devices.

These signals go to the inputs of the corresponding subtracting amplifiers 6 ~~$SA_1$ 5~~ and 5 ~~$SA_2$ 6~~. The subtracting amplifiers compare coming signals and generate difference signals $\pm\alpha=\Delta V_{\alpha 1}-\Delta V_{\alpha 2}$ and $\pm\beta=\Delta V_{\beta 1}-\Delta V_{\beta 2}$. These difference signals go respectively to the ~~first and the second~~ ~~inputs~~ inputs 9 and 14 of the commutation unit ~~CU~~10.

The ~~third and the fourth~~ 15 and 16 inputs of the commutation unit 10 are connected to the corresponding outputs of the ~~first~~ guidance device 3. The ~~fifth and the sixth~~ 17 and 18 inputs of the commutation unit 10 are connected respectively to the ~~third and the fourth~~ outputs of the ~~second~~ guidance device 4. In this case the outputs 21, 23, 47, and 49 ~~It is done in the way that the first, second, third and fourth outp~~ut of the commutation unit 10 are connected to the inputs of the corresponding actuators 20, 22, 46 ~~$A_1$7, $A_2$8, $A_3$11~~ and 48 ~~$A_4$12~~. The ~~fifth~~ output 51 of the commutation unit 10 is connected to the output of the ~~second~~ guidance device 4.

In the "b" mode the ~~third $A_3$ and the fourth $A_4$~~ actuators 46 and 48 are kinematically coupled to ~~connected with~~ the ~~second~~ mirror 19 ~~9'~~. The ~~second~~ mirror 19 ~~9'~~ is used for aiming solar rays at a ground object (a city) in night-time. The same mirror can be used as a passive reflector for communication between any two ground objects and for radiotelephone space communication in mountain areas. In this case, the ~~second~~ mirror 19 ~~9'~~ is automatically set perpendicularly to the optic axis of the ~~first~~ guidance device 3 ~~$GD_1$~~, which keeps tracking the radio beacon ~~X~~ placed in the center ~~centre~~ of a lighted ground object (a city).

In the "c" mode the ~~first and the second~~ actuators 20 and 22 are kinematically coupled ~~connected~~ to ~~with~~ the ~~first~~ mirror 19 ~~9~~. This small-size mirror is placed in the center ~~centre~~ of the coordinates, so that the zero ~~0~~ point should coincide with the center ~~centre~~ of the mirror, and is used for aiming of a high-power laser beam. This mirror is made of beryllium bronze and cooled by liquid helium.

In the "d" mode of directing a laser beam towards an enemy's target, the latter is used as an object. The ~~second~~ guidance device 4 ~~$GD_2$~~ is aimed at the laser (radiation source 2). On the ~~third~~ guidance device 5 ~~$GD_3$13~~ there is a laser, which

may be given the form of a cylinder whose axis (radiation) coincides with the optic axis of the ~~guidance device GD3~~ target seeker 44 of the guidance device 5. A light marker 44 or a radio beacon, which is coaxially placed in front of the laser so that the latter might be better distinguished against the ground surface. This determines employment of optical or radar sensors (transducers) of the ~~second~~ target seeker 53 (FIG.4). ~~$TS_2$~~. The first, second and third output are the outputs of the radar sensor, while the fourth, fifth and sixth ones are the outputs of the optical sensor.

By the ground command the radio receiver 33 ~~17~~ (Fig.2) with an antenna A ~~aerial Ar~~ shifts a three-contact switch to one of the four positions (I, II, III, IV). Depending on the position of the contacts 55, 56, 36 of the switch 37 the ~~switch~~, actuators 20, 22, 46 and 48 ~~$A_1$, $A_2$, $A_3$ and $A_4$~~ receive signals from the outputs of the subtracting amplifiers 6 and 11 or from the respective ~~third and the fourth~~ outputs of the ~~first~~ guidance device 3. Besides, the contacts 55, 56, 36 of the switch 37 ~~18~~ connects the commutation output 51 of the commutation unit ~~CU~~ 10 with the output of the source 59 of a unit signal (+$V_1$) ~~19~~ (position IV).

With the contacts 55, 56, and 36 of the contacts 55, 56, 36 of the ~~The~~ switch 37 ~~18~~ in the upper (I) position, the system works in the "a" mode. The outputs of the subtracting amplifiers 6 ~~5~~ and 11 ~~6~~ ~~through commutators 15, 16~~, are connected, through commutators 31, 53, respectively, to the inputs of the ~~first and the second~~ actuators 20 ~~7~~ and 22, respectively ~~8~~. The system controls the ~~central~~ first central metal mirror 19 ~~9~~.

In this case, at the output 51 of the commutation unit 10 there appears 95 a unit signal +$V_1$, which goes to the commutation input of the ~~second~~ guidance device ~~$GD_2$~~ 4.

In this case the system is used for aiming a powerful laser beam at the target. The source 2 of radiation ~~1~~ (a laser) is installed on the ~~third~~ guidance device 5 ~~$GD_3$ 13~~. By reducing control signals to zero in two ~~2~~ planes, the ~~third~~ guidance device 5 ~~13~~ aims the laser at the light marker 66 (or a corner ~~corner~~ reflector), placed in front of the target seeker 53 of the ~~second~~ guidance device 4 ~~$GD_2$~~.

The ~~second~~ guidance device 4, in its turn, is aimed at a light marker (a radio beacon) placed in front of the source (laser) ~~laser~~ 2. When the output signals from the target seekers 53 ~~of the second 4~~ and 44 of the ~~the third 13~~ guidance devices 4 and 5 become zero, their optic axes coincide, and the laser beam hits Point 0 ~~Ø~~. After the error has been minimized,

the optic axis of the target seeker 44 ~~$TS_1$~~ of the ~~first~~ guidance device 3 ~~$GD_1$ 4~~ comes to coincide with the direction "0 ~~Ø~~ – ~~an~~ object". Difference signals from the outputs of the subtracting amplifiers 6 and 11 having been reduced to zero by the actuators 20 ~~$A_1$ 7~~ and 22 ~~$A_2$ 8~~, the ~~first~~ mirror 19 takes a next ~~the following~~ position. The normal $\tilde{n}$ in the Point O (origin of the coordinates) becomes a bisector ~~bisectrix~~ of the angle between optic axes of the target seekers 44 and 53 of the ~~first and the second~~ guidance devices 3 and 4. The incident laser beam, after having been reflected by the ~~first~~ mirror 19 ~~9~~, hits the target 1.

To start a giant-pulse laser, an excitation pulse should be applied at the instant ~~moment~~ when the output signals of all target seekers 44 and 53 of guidance devices 3 ~~$TS_1$~~, 4 ~~$TS_2$~~, and 5 ~~$TS_3$ 3, 4, 13~~ and of the subtracting amplifiers 6 ~~5~~ and 11 ~~6~~ come to zero. The outputs of the subtracting amplifiers should be connected to the AND gate 62 ~~"$I_1$" element 20~~ provided with the NOT inverter 63 ~~$HE_1$ 21~~. A unit signal from the output of the inverter 63 excites ~~starts~~ the laser. Information about zero values of the signal at the outputs of target seekers 44 and 53 and of the subtracting amplifiers 6 and 11 may be transmitted through radio or laser commutation.

The middle position (II) of the contacts 55, 56 and 36 of the contacts 55, 56, 36 of the switch 37 ~~switch~~ corresponds to the zero value of the signal at the ~~second~~ inputs 60, 61 of the commutators 31 and 53. ~~first 15 and the second 16 commutator~~. In this case, the outputs of the subtracting amplifiers 6 and 11 are switched to the inputs of the ~~third $A_3$ and the fourth $A_4$~~ actuators 46 and 48, i.e. the system controls the ~~second~~ film mirror 19 ~~9'~~.

The contacts 56 and 36 of the contacts 55, 56, 36 of the switch 37 ~~second and the third contact of the switch 18~~ connect the outputs of the commutators 31 ~~15~~ and 53 ~~16~~ to ~~with~~ the inputs of the ~~third and the fourth~~ actuators 46 and 48. These actuators minimize error signals coming to the corresponding ~~first~~ inputs of the commutators 31 ~~15~~ and 53 ~~16~~ from the outputs of the subtracting amplifiers 6 ~~$SA_1$ 5~~ and 11 ~~$SA_2$ 6~~. By turning the ~~second~~ film mirror 19 ~~9'~~, the system can provide space communication between two ground objects, which have to be equipped with radio beacons. The ~~first~~ guidance device 3 is pointed to the object (radio beacon) 1, while the ~~second~~ guidance device 4, ~~7~~ to the second radio beacon. The ~~second~~ mirror 19 ~~9'~~ is automatically adjusted in such a way that a beam, radio-frequency radiation in the VHF or microwave range or a laser beam after having been reflected by the metal coating of the mirror 19 ~~9~~ hits the second ground object, and vice versa. With a view to secrecy the ~~first~~ (small)

mirror ~~9~~ 19 can be used. This is how the space communication between two ground objects can be carried out.

With the contacts 55, 56, 36 of the 37 switch ~~18~~ in the third (III) position, the unit signal $+V_1$ from the source output 59 goes to the ~~second~~ inputs 60 and 61 of the ~~first and the second~~ commutators ~~15,~~ 31 and 53, ~~16 and makes them~~ which pass the signals from the corresponding ~~third ($V_3$) and the fourth ($V_4$)~~ outputs 15 and 16 of the first guidance device ~~$GD_1$~~ 3, to the outputs of the commutation unit 10. These signals from the corresponding ~~first and the second~~ outputs of the target seeker ~~$TS_1$~~ 44 of the ~~first~~ guidance device ~~$GD_1$~~ 3 go to the inputs of the ~~third and the fourth~~ actuators 46 and 48 which follow to indicate them. In this case the ~~second~~ mirror ~~9~~ 19 becomes perpendicular to the optic axis of the ~~first~~ guidance device ~~$GD_1$~~ 3 directed towards the object 1 (radio beacon) ~~1~~.

With the contacts 55, 56 and 36 of the radio-controlled switch ~~19~~ 37 in the fourth (IV) position, the system works in the "**d**" mode. In this case, the unit voltage $+V_1$ from the output of the unit ~~18~~ 59 goes to the ~~fifth~~ output 51 of the commutation unit 10. This output is connected to the input of the ~~second~~ guidance device ~~$GD_2$~~ 4.

The fourth operation mode "**d**" demands that the ~~second~~ guidance device 4 should have a target seeker ~~$TS_2$ 32~~ 53 (~~see~~ Fig.4) with the sensors working within both the optical range (the outputs 1,2,3), and the radio frequency band (the outputs 4, 5, 6).

In comparison with the ~~first 3 and the third 13~~ guidance devices 3 and 5 (~~see~~ Fig.3), the ~~second~~ guidance device ~~$GD_2$~~ 4 (~~see~~ Fig.4) has the additional ~~fifth, sixth, seventh, eighth and ninth commutator~~ commutators 59, 60, 61, 62 and 63. With ~~no~~ the zero unit signal at the commutation input ~~37~~, the first, second and third outputs of the target seeker 53 are connected to the corresponding inputs of the search signal conditioner ~~31~~ 60 through commutators ~~32~~ 59, ~~33~~ 60 and ~~34~~ 61. Besides, the first and ~~the~~ second outputs of the target seeker ~~23~~ 53 are connected to the first inputs of the ~~third 29 and the fourth 30~~ commutators 62 and 63 through the ~~eighth 35 and the ninth 36~~ commutators 64, 44.

With the zero signal at the ~~second~~ inputs of ~~these~~ the commutators ~~(29 and 30)~~ 51 and 52, the first and ~~the~~ second outputs of the ~~$TS_3$ 23~~ target seeker 44 are connected respectively to the inputs of the ~~fifth 25 and the sixth 26 actuator~~ actuators 46 and 47. Thus, with a zero signal at the

commutation input of the ~~third~~ guidance device 4, it works in the same way as the ~~first 3 and the third 13~~ guidance devices 3and 5 ~~(see~~ Fig.3).

In the lower position (IV) of the contacts 55, 56and 36 of the radio-controlled switch ~~18~~ 37 a unit signal $+V_1$ goes to the commutation input ~~46~~ of the ~~second~~ guidance device 4.

In this case, the ~~fifth, sixth and seventh~~ commutators ~~38, 39, 40~~ 59, 60, 61 let signals from the ~~corresponding~~ respective fourth, fifth and sixth outputs of the ~~$TS_2$ 32~~ target seeker 53 pass to the input of the search signal conditioner ~~($SSC_2$) 45~~ 66.

At the same time, the ~~tenth 43 and the eleventh 44~~ commutators 64 and 44 let signals from the fourth and the fifth outputs of the target seeker 53 of the ~~second~~ guidance device 4 pass to the first inputs of the ~~eighth 41 and the ninth 42~~ commutators 62 and 63. ~~(see Fig.3a).~~

In this case the ~~radiosensors~~ optic sensors of the ~~second~~ target seeker ~~32~~ 53 of the ~~third~~ guidance device ~~$GD_2$~~ 4 ~~work~~ operate.

Target seekers ~~$TS_1$ 23~~ 44 of the ~~first 3 (and the third 13)~~ guidance devices 3and 5 work in the radio-frequency range.

As for the rest, principles of operation of the guidance devices 3, 4, and ~~13~~ 5 coincide.

If it is necessary to work in the optical range, the guidance devices of the ~~$GD_2$~~ type of those under Ref. No. 4 can be used, with a unit signal $+V_1$ given to the commutation input.

The object 1 comes into the field of vision of the ~~first~~ guidance device ~~$GD_1$~~ 3. When the object does not coincide with the optic axis of the ~~$GD_1$~~ target seeker 44, control signals ~~at~~ of the ~~$TS_1$ output~~ target seeker 44 are ~~different from~~ other than zero.

Difference signals from the ~~$TS_1$ 23~~ target seeker 44 go to the ~~fifth $A_5$25 and the sixth $A_6$26~~ actuators 46 and 47 (servomotors) to be ~~reproduced~~ executed. The ~~first 72 and the second 73~~ brackets 109 and 110 together with the corresponding servomotors ~~25~~ 46 and ~~26~~ 47 turn the target seeker ~~$TS_1$~~ 44 about the axes OX and OY. The optic axis of the ~~$TS_1$~~ target seeker 44 is always directed towards the Point O, i.e., towards the ~~centre~~ center of the sphere, on which the target seeker ~~$TS_1$ 23~~ 44 moves. Difference signals from the ~~$TS_1$~~ target seeker 44 have been reproduced, the target seeker ~~$TS_1$ 23~~ 44 takes such a position that its optic axis coincides with the direction towards

the object (radio beacon) 1. When a system for lighting of an object is established on a mobile object, e.g., onboard a flight vehicle, it should be placed on a gyro-stabilized ~~stabilised~~ platform in order to provide gyroscopic decoupling. Angular position of the ~~first~~ target seeker 44 ~~$TS_1$ 23~~ with respect to the platform in two planes of control can be measured with the aid ~~help~~ of the ~~first $APP_1$ 27 and the second $APP_2$ 28~~ angular position pickups 48 and 49 (synchro transmitters or potentiometers).

For guiding a pencil-beam antenna ~~aerial~~ of the automatic direction-tracking system ~~ADT~~ the method of radio direction finding is used [4].

In the radio-frequency range, two antennas of the automatic direction-tracking system ~~$ADT_1$ and $ADT_2$~~ are used instead of the target seekers 44 ~~$TS_1$~~ and 53 ~~$TS_2$~~.

A transmitting antenna of the radar station ~~RS~~ is placed in the center ~~centre~~ of a lighted ground object (e.g., a city) and radiates electromagnetic waves into the ambient space. To reduce power of the ~~radio~~ automatic radio direction-tracking device (automatic direction-tracking system), the target seeker 44 ~~(ADT), $TS_1$ 23~~ may be equipped with a corner reflector 45.

The corner reflector consists of three reflective plates adjusted perpendicularly to each other. In the corner reflector, incident energy from the radar station, having been two or three times reflected by the surfaces of the three plates, is reverted in the direction the radiation has come from. Thus, a small-sized corner reflector is capable of creating ~~to create~~ reflection of high intensity [4].

The transmitting antenna ~~aerial~~ of the radar station with the aid ~~help~~ of an automatic direction-tracking device ~~(ADT)~~ is oriented to the corner reflector and points electromagnetic waves thereto ~~to it~~. The first automatic direction-tracking device ~~($ADT_1$)~~, in turn, directs the axis of the ~~first~~ target seeker 44 ~~$TS_1$ 23~~ (which coincides with the equisignal direction of the automatic direction-tracking device ~~$ADT_1$~~) towards the source of radiation, that is, a first radar station. ~~- RS 1~~.

The first and third automatic direction-tracking devices ~~$ADT_1$ and $ADT_1$ 3~~ can be designed to use the method of conical scanning of an antenna ~~aerial~~ beam or the monopulse measuring of angular coordinates; the latter guarantees a higher degree of accuracy and allows of using ~~permits to use~~ both pulse and continuous energy radiation [4].

It is known that with the first method used, deviation of an object from an equisignal direction is accompanied by the maximum beam alternately coming nearer to the object or receding ~~from it~~ therefrom. Owing to this, impulses of return signals are modulated in amplitude with a conical-scan frequency of the beam, while modulation depth depends on the value of the error. The curve, which turns tops of reflected pulses, is an error signal. The initial phase of the envelope curve depends on how far the object deviates from the equisignal position in azimuth and angle of elevation. Automatic tracking lies in automatic rotating of the ~~aerial~~ antenna axis until the error signal becomes zero. When error signals of the ~~both ADT~~ automatic direction-tracking devices become zero, the equisignal lines of transmitting and receiving ~~aerials~~ antennas come to coincide and the axis of the ~~first~~ target seeker ~~$TS_1$~~ 44 is now directed towards the radiating ~~aerial~~ antenna of the ~~RS 1~~ first radar station.

The ~~second~~ target seeker ~~$TS_2$ 32~~ 53 is directed towards the Sun with the ~~help~~ aid of the ~~third 74 and the fourth 75~~ brackets 95 and 94 and the ~~corresponding seventh $A_7$ 34 and the eighth $A_8$ 35~~ actuators 55 and 56 (servomotors) of the ~~second~~ guidance device ~~GD 4~~ 4 kinematically ~~attached to them~~ coupled thereto. Angular position of the target seeker ~~$TS_2$ in~~ 53 with respect to the gyro-~~stabilised~~ stabilized platform is measured by the ~~third and the fourth~~ angular position pickups ~~36~~ 57 and ~~37~~ 58. When ~~$TS_2$~~ the target seeker 53 turns about the axes OX and OY, its own optic axis always goes through the origin of OXYZ coordinates.

CCD-rulers used in the target seeker for aiming at the Sun are not damaged if locally overlit and do not get out of order even at a thousandfold increase of a luminous flux in comparison with the flow of saturation. To increase noise immunity of the Sun seeker, CCD-rulers' lenses are ~~additionally~~ further equipped with optical filters, e.g., of the IRS-7 type, which transmit radiation only of the near-infra-red region, and with neutral filters, that diminish brightness of the solar disk image to required values.

Whichever position the target seekers ~~$TS_1$~~ 44 and ~~$TS_2$~~ 53 moving on the surface of the sphere may take, their optical axes intercross ~~in~~ at the ~~centre~~ center of the O sphere.

The ~~second~~ mirror ~~8~~ 19 is installed on a gimbal mount. The gimbal mount, which consists of ~~the~~ an internal ~~76~~ frame 98 and ~~the~~ an external ~~77~~ frame 99 kinematically ~~attached~~ coupled to the ~~corresponding third $A_3$ 11 and the fourth $A_4$ 12~~ respective actuators (servomotors) ~~11~~ 25 and ~~12)~~ 27, provides for rotation of the mirror about the axes OY and OX.

To direct incident sun rays, which coincide with the optical axis of the ~~$TS_2$~~ target seeker 53, along the "O-target" line (coincident with the optic axis of the ~~$TS_1$~~ target seeker 44), subtracting amplifiers (comparators) ~~$SA_1$ 5~~ 6 and ~~$SA_2$ 6~~ 11 are used.

The ~~I~~ inputs of the ~~first~~ subtracting amplifier ~~$SA_1$ 5~~ 6 are connected to the outputs of the ~~first $GD_1$ 3 and the second $GD_2$ 4~~ guidance devices 3 and 4. In position I of the switch ~~18~~ 37 the outputs of the ~~first~~ subtracting amplifier ~~$SA_1$~~ 6 are connected to the inputs of the ~~first~~ actuators ~~$A_1$ 11~~ 20 which. ~~The $A_1$~~ provide~~s~~ rotation of the ~~first~~ mirror ~~8~~ 19 about the OY axis. The ~~first and the second~~ inputs of the ~~second~~ subtracting amplifier ~~$SA_2$ 6~~ 11 are connected to the respectively ~~to the second~~ outputs of the ~~first $GD_1$ and the second $GD_2$~~ guidance devices 3 and 4. The output of the ~~$SA_2$~~ subtracting amplifier 11 is connected to the input of the ~~second~~ actuators ~~$A_2$~~ 22. which ~~The $A_2$~~ provide~~s~~ rotation of the mirror about the OX axis.

The subtracting amplifiers (comparators) ~~5~~ 6 and ~~6~~ 11 generate difference signals $\Delta U = U_1 - U_2$, where $U_1$ and $U_2$ are voltage values ~~removed~~ taken off from two angular position pickups 46, 47, and 57 and 58 ~~of the $GD_1$ and $GD_2$,~~ (e.g., ~~from~~ potentiometers) of the guidance devices 3 and 4. Movable contacts of the potentiometers are kinematically ~~attached~~ coupled to brackets, with the ~~help~~ aid of which the target seekers ~~$TS_1$~~ 44 and ~~$TS_2$~~ 53 are directed towards the object 1 and the radiation source 2. The subtracting amplifier is built around an operational amplifier. The difference signal $\Delta U$ at the output of the subtracting amplifier is proportional to the difference ~~of~~ between the angles $\Delta\alpha$ (or $\Delta\beta$) in two planes of control (XOZ and YOZ). The difference signal $\pm\Delta U$ goes to the ~~corresponding~~ respective actuators ~~$A_1$ 11~~ 20 and ~~$A_2$ 12~~ 22, which ~~follow to indicate them and~~ rotate the mirror 19 about the OX and OY axes ~~in order~~ to reduce error signals to zero.

~~With an~~ When the object of the ~~first~~ target seeker ~~$TS_1$~~ 44 comes out of sight, the system ~~goes into~~ starts operating in the search ~~operation~~ mode. In this case, the inputs of the ~~fifth and the sixth~~ actuators 46 and 47

~~through the third 29 and the fourth 30 commutators~~ are connected to the outputs of the search signal conditioner ~~$SSC_1$ 31~~ 50 through the commutators 51 and 52.

Similarly, with the source 2 of radiation ~~2~~ out of sight of the ~~second target seek~~er ~~32 of the second~~ guidance device 3 and 4, ~~$SGD_2$ 4~~, the inputs of the ~~seventh 34 and the eighth~~ 55 and 56 ~~35~~ actuators are connected to the outputs of the search signal conditioner 66. ~~$SSC_2$ 45~~.

The search signal conditioners ~~$SSC_1$ 31~~ 50 and ~~$SSC_2$ 45~~ 66 of the guidance devices ~~$GD_1$, $GD_2$~~ 3 and 4 shape two signals of ramp amplitude in phase quadrature (sin φ, cos φ). Having received such signals, the actuators ~~$A_5$ 25'~~ 46 and ~~$A_6$ 26'~~ 47 (~~34~~ 55 and ~~35~~ 56) rotate ~~$TS_1$ ($TS_2$)~~ target seeker 44 (53) about the OX and OY axes so that the optic axes of the target seekers 44 (53) are scanned along ~~the~~ a spiral sweep-trace.

When the Sun comes into the field of vision of the ~~second~~ target seeker 53, its radiation is registered with the ~~help~~ aid of ~~optical-electronic~~ optoelectronic transducers. ~~of the $TS_2$ 32. So,~~ Its outputs send sync pulses from the outputs of the synchronizing signal generator to the sync inputs 104 of the ~~92 SSC~~ search signal conditioner 50 (66), while the ~~first 90 and the second 91~~ inputs 102 and 103 of the ~~$SSC_2$~~ search signal conditioner receive normalized signals coming from the outputs of the target signal detectors. Having received ~~the~~ both signals from the outputs of the target signal detectors, the system goes into the tracking operation. The commutators ~~41, 42, 43, 44~~ 62 63 64 and 65 connect inputs of the ~~$A_7$ and $A_8$ to the target seeker $TS_2$ 32 outputs of the $GD_2$~~ actuators 55 and 56 to the outputs of the target seeker 44 of the guidance device 3.

The search signal conditioners ~~($SSC_1$) 31~~ 50 and ~~($SSC_2$) 45~~ 66 ~~work as described below~~ functions as follows (~~see~~ Fig. 9).

If there is no target pulse in the interval between two successive sync pulses (at least, at one of the ~~$SSC_1$ information~~ data inputs), then at the output of the logical ~~unit (LU) 103~~ set 101 there appears a level of the logical unit, which prevents recording new information in the devices 111 and 112 of storage sampling ~~$DSS_1$ 84 and $DSS_2$ 85~~ 112 (operation of the logical set will be described below). At the ~~moment~~ instant of changeover at the ~~LU 103~~ output of the logical unit 101 from zero to one, that is, along the pulse leading edge, the voltage at the output of the ~~GLCV (~~generator 105 of linearly changing voltage ~~)~~ ~~79 steps down~~ becomes equal to zero and starts ~~to increase~~ increasing linearly (from zero).

The ~~o~~Output voltage of the generator 105 ~~GLCV~~ modulates harmonic signals from the outputs of the quadrature generator 108 ~~78~~ by means of modulators 106 ~~$M_1$ 70~~ and 107 ~~$M_2$ 71~~, with the signals at the ~~generator 88~~ outputs of the quadragenerator 108 being 90-deg out of phase. This allows of having harmonic signals of ramp amplitude in phase quadrature (sine and cosine) at the outputs of the amplitude modulators 106 ~~80~~ and 107 ~~81~~.

At the outputs of the ~~first and the second~~ summers 109 ~~72~~ and 110 ~~73~~ there appear voltage values equal to the sum of voltage values at the outputs of the respective ~~corresponding~~ modulators 106 ~~80~~ and 107 ~~81~~ and the sample-and-storage devices 111 and 112 ~~$DSS_1$ 84 and $DSS_2$ 85~~, i.e., $U_3$ ~~$U_{DSS1}$~~ + $U_4$ ~~$U_{M1}$~~ = $U_{\Sigma 1}$, where $U_3$, $U_4$, ~~$U_{DSS1}$, $U_{M1}$ and~~ $U_{\Sigma 1}$ are voltage values at the respective ~~outputs~~ of the device 112 ~~$DSS_1$~~, modulator 107, ~~$M_1$~~ and the summer 110 ~~$\Sigma_1$~~.

~~Similarly to $U_{DSS2} + U_{M2} = U_{\Sigma 2}$, t~~The analog-digital ~~analog-to-digital~~ converters 113 ~~$ADC_1$ 86~~ and 114 at the outputs of the summers 109 and 110 ~~$ADC_2$ 87~~ convert the voltage at the outputs of the ~~corresponding~~ summers 109 ~~82~~ and 110 ~~83~~ into a respective digital signal. When there are demanded from the search signal conditioners 50 and 66 control search signals in an analog form, ~~If the $SSC_1$ and $SSC_2$ are required to produce analog-formed control signals,~~ the analog-to-digital ~~analog-digital~~ converters ~~$ADC_1$ 86 and $ADC_2$ 87~~ are not necessary.

Space scanning can be achieved by angular position pickups ~~application~~ of the signal from the outputs of the summers 109 ~~82~~ and 110 ~~83~~ (by means of the analog-to-digital converters 113 and 114 ~~$ADC_1$ 86 and $ADC_2$ 87 $ADC_2$ 87~~) to the ~~fifth and the sixth (the seventh and the eighth)~~ actuators 46, 47 (55, 56) of the guidance devices 3(4) ~~$GD_1$ ($GD_2$)~~, which provide rotation of the target seeker 44 (53) ~~$TS_1$ 23 ($TS_2$ 32)~~ in two mutually perpendicular planes about the OX and OY axes of the OXOY coordinate system connected to ~~with~~ the gyro-stabilized ~~stabilised~~ platform. Position taken by the start of the spiral depends on the voltage values at the outputs of the sample and storage devices 111 and 112 ~~$DSS_1$ 84 and $DSS_2$ 85~~, i.e., these values are proportional to the tangents of the angular coordinates.

If a radio beacon or the Sun comes into the field of view of the target seeker 44 (53) ~~$TS_1$ 23 ($TS_2$ 32)~~, the radiation is recorded with the aid ~~help~~ of detectors or optoelectronic ~~optical-electric~~ converters. In this case, at the outputs of the target detectors ~~TD~~ there appear target detection pulses ~~of target detection~~ [3], which will assure the level of logical zero at the output of the logical unit 101 ~~103~~. At that instant ~~this moment~~, instantaneous (current) voltage values are recorded at the outputs of the corresponding summers 109 ~~82~~ and 110 ~~83~~ along

the trailing edge of the ~~LU 89~~ output of the logical unit 101 in the ~~DSS₁ 84 and DSS₂ 85~~ devices 111 and 112, and zero voltage is provided at the ~~GLCV output~~ output of linearly varying voltage generator 105. As long as the target is ~~in~~ across the beam ~~path,~~ pathway the logical ~~set~~ unit 101 will shape "I", thus providing zero voltage at the ~~GLCV 79~~ output of the generator 105, while at the output of the summers ~~82~~ 109 and ~~83~~ 110 voltage remains the same, since the ~~DSS₁ 84 and DSS₂ 85~~ devices 111 and 112 store the voltage values produced at the outputs of the summers ~~82~~ 109 and ~~83~~ 110 at the ~~moment~~ instant of "0" appearing at the ~~LU 89~~ output of the logical unit 101 (i.e. $\cancel{U_{DSS1}}$ $U_3 = U_{\Sigma 1}$), and "0" at the ~~GLCV~~ output of the generator 105 (i.e. $\cancel{U_{MI}}$ $U_4 = 0$).

This is how the stationary position of the mirror ~~9~~ 19 is obtained. When the target leaves the field of vision of the ~~TS₁ 23 or (TS₂ 32)~~ target seeker 44 or 53, the level of the logical unit appears at the ~~LU 89~~ output of the logical set 101, the generator 105 ~~the GLCV~~ starts ~~to produce~~ generating ramp voltage, recording in the ~~DSS₁ 84 and DSS₂ 85~~ devices 111 and 112 is blocked and the process (spiral sweep) starts, the ~~centre~~ center of the spiral being in the straight line, which ~~crossed~~ was crossing the target at the ~~moment of its~~ instant when the target was leaving the field of vision of the target seeker.

If there is no target in the field of view of the target seeker and the voltage at the ~~GLCV~~ output of the generator 105 has reached some ~~value assigned in advance and~~ preset value (which is determined by the field of vision of the system), the ~~GLCV~~ generator 105 resets the output voltage and the entire above-mentioned process starts anew.

The quadrature generator ~~88~~ 108 can be designed as shown in Fig. 5.12, on page 137 [7], the ~~DSS~~ sample-and-storage devices, as in Fig. 3.1, on page 77 ~~[7]~~ (cf. op.cit.). To prevent the ~~DSS~~ sample-and-storage devices and the summers from inversion, they should be ~~placed~~ connected in series with ~~invertors~~ inverters that have a ~~unit~~ gain factor equal to 1 ~~(see~~ Fig. ~~1.8."e"~~ 1.8b, page 18 ~~[7])~~ (cf. op. cit.).

The ~~analog-digital~~ analog-to-digital converter ~~(ADC)~~ can be ~~realised~~ realized in a circuit design shown in ~~[6] (see Fig. 24, 23, page 458)~~ the textbook "Linear integral circuits" by V.L.Shilo, "Sovetskoe radio" Publishers, Moscow, 1979, FIGS. 27, 24, 23, page 458 (in Russian).

For the modulators 106 and 107 it is possible to use standard amplitude modulators, with their control inputs connected to the ~~LU~~ output of the logical unit 101 and carrier frequency inputs, to the corresponding outputs of the quadrature generator 108.

The ~~GLCV~~ generator 105 may be built around a standard generator of the saw-tooth growing voltage type.

In the above-mentioned shaper it is possible to use chips of the K153UD2, ~~K140UD7~~ K161UD7, ~~K140UD8~~ K161UD8, K154UD2 type, insulated-gate field-effect transistors, capacitors with a small loss tangent, etc.

The logical unit ~~89~~ 101 can be designed as shown in Fig. ~~7~~ 10. It ~~operates~~ functions as ~~described below~~ follows.

A ~~synchronising~~ synchronizing pulse, which has come ~~to~~ at the input ~~91~~ 103 through the inverter ~~102~~ 121, sets the ~~first 97 and the second 98~~ flip-flops 117 and 118 to zero along the pulse trailing edge, since K155TM2 chip based flip-flops, ~~which are used here~~ made use of herein, are ~~switch~~ switched at the changeover from "0" to "1".

~~On~~ Along the leading edge of the sync pulse, information from the above-mentioned flip-flops 117 and 118 is copied into the ~~third 99 and the fourth 100~~ flip-flops 119 and 120 (these flip-flops are also based on the K155TM2 chips). The four flip-flops operate in this way because pulses that come to their sync inputs are out of phase.

The ~~first 97 (or the second 98)~~ flip-flop 117 (118) will be in the unit state ~~given~~ provided that within the current period between two successive sync pulses there is a circuit pulse from the corresponding target detector ~~(TD)~~ that comes to the input ~~90 (102)~~ 102. Otherwise, the flip-flop stays in the zero state. After arrival of the sync pulse, this information is copied into the third ~~99 (the fourth 100)~~ flip-flop 119 (120).

Thus, a logical unit appears at the direct input of the ~~third 89 (the fourth 90)~~ flip-flop 119 (120) on condition that within the given period between two successive sync pulses there is an object pulse from the output of the corresponding target detector ~~(TS) output~~; otherwise the signal takes the zero value.

The zero state of either of the two ~~99 and 100~~ flip-flops 119 and 120 results in the level of a logical zero at the ~~LU~~ output of the logical unit. This is provided by the "I" element ~~91~~ 122, which ~~can~~ may be based on a K155LI1 chip.

The inverters can be based on chips of the K155LN1 type.

In the systems for lighting of an object, according to the invention, it is possible to use gyroscopic, electromechanical or electrohydraulic actuators. The first ones seem preferable, as they are inertialess ~~[1]~~ (cf. the textbook "Infrared systems", by L.Z. Kriksunov and I.F. Usoltsev "Sovetskoe radio" Publishers, Moscow, 1969, pp. 157-239 (in Russian)). In this case the target seeker's axis deviates from the direction

required, correctional sensors, which are connected to ~~with~~ the axes of the frames and receive signals, develop ~~create~~ torques that make the gyro precess in the direction of the object.

By measuring the strength of current in windings of correlation sensors (the value of the moments) it is possible to determine projections of the angular velocity vector of the observing line on two mutually perpendicular directions [1]. Wipers ~~Wapers~~ of potentiometer transducers fixed on the rotation axes of the gimbal joint frames will and ~~help~~ to determine angular coordinates in respect to the platform, on which the gyroscope is installed. In this case, sensor cases should be rigidly attached to the platform ~~[1]~~ (cf. the textbook "Infrared Systems", by L.Z. Kriksunov and I.F. Usoltsev "Sovetskoe radio" Publishers, Moscow, 1968, pp. 157-239 (in Russian)). *[Insert B attached]*

In electromechanical autotracking systems direct current engines ~~[1]~~ can be used as servomotors (cf. the textbook "Infrared systems", by L.Z. Kriksunov and I.F. Usoltsev "Sovetskoe radio" Publishers, Moscow, 1968, pp. 157-239 (in Russian)). Taking into account values and signs of output signals, servomotors correct misalignments between the target seekers' axes and the direction towards the object. Wipers ~~Wapers~~ of potentiometer transducers or synchro transmitters fixed on rotation axes of the frames of the coordination unit produce signals, which determine angular position of the target seekers in relation to the axis of the controlled object.

To obtain a signal proportional to angular velocity of the observing line, tachogenerators are used, kinematically coupled ~~attached~~ to the shafts of servomotors. The same tachogenerators can be used as elements of vanishing feedback. Information about the angular position and angular velocity of the servo drive's observing line is used for control of an object. Signals proportional to the angular position of the coordinators are received from potentiometers or synchro transmitters fixed on the rotation axes of the gimbal mount frames, while signals proportional to the angular velocity of the observing line come from resistors inserted into the windings circuit of correction torque motors of the gyroscopic drive or from tachogenerators, kinematically coupled ~~attached~~ to servomotors of the electromechanical drive.

In addition to automatic lighting of ground objects the system provides information about the angular position of the target in relation to the OZ-axis. For

INSERT B

Having stopped the wipers of potentiometer transducers on the axes of rotation of the frames of a gimbal unit, one can find the angular coordinates with respect to the platform on which the gyroscope is held in position. In such a case the casings of the transducers should be locked-in with the platform (cf. the textbook "Infrared systems", by L.Z.Kriksunov and I.F.Usoltsev "Sovetskoe radio" Publishers, Moscow, 1968, pp.157-239 (in Russian).

this purpose, information about the angular position of a ground object is obtained from the outputs of the angular position pickups ~~APP$_1$ 27~~ 48 and ~~APP$_2$ 28~~ 49 (FIG.3). The ~~presentational~~ system of the present invention, in comparison with ~~its~~ the prototype, allows of automatic illumination of ground objects from outer space. It also permits ~~to increase~~ increasing the accuracy of measuring angular coordinates of the target, since the beam is aimed at the ~~centre~~ center of the target image.

## Subject bibliography


1. cf. L.Z.Kriksunov, I.F.Usoltsev. *Infrared systems*. Moscow, "Sovetskoye Radio" Publishing House, 1968, p.p. 157-239, (in Russian).
2. cf. I.I.Shumeiko (editor). *Astronautics and rocket dynamics*. Express information, № 43, Moscow, 1989, p.p. 27-34, (in Russian).

(cf. DE Application #A 3,412,0763)

3. ~~Application in Germany, № 3412076, G01 B 11/03. *A system for determination of two-dimensional coordinates of a light spot*~~.

US Pat. A<#3,946,233

4. ~~Patent of USA, № 3946233. *A weapons system for detection and usage against fixed and moving targets*~~.
5. Ye.K.Sonin. Avionics of space vehicles. Moscow, "Energia" Publishing House, 1972, p.p. 6-17, 24-33, 72-92.
6. V.L.Shilo. Linear integrated circuits. Moscow, "Sovetskoye Radio" Publishing House, 1979, p. 158.

(The textbook by A.G. Alekseenko, K.A. Kolombet, G.I. Starodub, "Application of precision analog IC", "Sovetskoe radio" Publishers, Moscow, 1980)

7. ~~A.G.Alekseenko, K.A.Kolombet., G.I.Starodub. *Application of precision analog IC*. Moscow, "Sovetskoye Radio" Publishing House, 1980~~.


## Formula of the invention

**Item 1.** The system for lighting of an object includes a source of radiation, the first guidance device optically integrated with an object, and the first mirror, kinematically bound with the first and the second actuators. The system is

distinguished by the additional second guidance device, the first and the second subtracting amplifier, a commutation unit, the third and the fourth actuators, and the second mirror, kinematically bound with the third and the fourth actuators. Inputs of these actuators are connected to the corresponding outputs of the commutation unit, whose first and second input are connected to the outputs of the corresponding subtraction devices. The first and the second inputs of these subtraction devices are, in turn, connected respectively to the first and the second output of the first and the second guidance device, while the input of the second guidance device is connected to the fifth output of the commutation unit. The first and the second output of the commutation unit are connected to the corresponding actuators, its third and fourth input are connected to the corresponding outputs of the first guidance device, while the fifth and the sixth input respectively to the third and the fourth output of the second guidance device.

**Item 2.** The system for lighting of an object in accordance with Item 1 distinguished by the following: a commutation unit, which includes the first and the second commutator, the first radio receiver, a three-contact four-position radio-controlled switch, the first source of unit voltage, the first "I" element, the first inverter and a radio transmitter. The first and the third inputs of the first and the second commutator are, at the same time, respectively the first - fourth inputs of the commutation unit. The first and the third output of the commutation unit by a radio-controlled switch are connected to the output of the first commutator, the second and the fourth output – to the output of the second commutator, the fifth output, with the switch in the third position, - to the output of the unit voltage source. Besides, the second and the third contact of the switch in the second-fourth positions of the switch are paralleled; in the third position the output of the unit volltage source is connected to the paralleled second inputs of the first and the second commutator. Meantime, the first - sixth input of the "I" element are connected to the corresponding first - sixth input of the commutation unit, while the output of the "I" element is connected through the inverter to the radio transmitter.

**Item 3.** The system for lighting of an object in accordance with Item 1 distinguished by the following: the first (third) guidance device has the first target seeker, the fifth and the sixth actuators, the first and the second angular position pickup, kinematically connected with each other. Inputs of the angular position pickups serve, at the same time, as the corresponding first and second output of the guidance device, which, in addition, has the first search signal conditioner and the third and the fourth commutator. The first outputs of these commutators are connected respectively to the first and the second output of the target seeker, whose first, second and third output is connected to the corresponding inputs of the search signal conditioner. The first and the second output of the search signal conditioner are connected to the third inputs, while its third output - to the paralleled second inputs of the third and the fourth commutator, the outputs of which, are, in turn, connected to the corresponding i nputs of the fifth and the sixth actuators.

**Item 4.** The system for lighting of an object in accordance with Item 1 and Item 2 distinguished by the following: the second guidance device has a target seeker equipped with a light marker (or a corner reflector), the seventh and the eighth actuators, the third and the fourth angular position pickups, whose outputs are at the same time the first and the second output of the guidance device, the fifth - eleventh commutators and the second search signal conditioner. The first inputs of the fifth, sixth and seventh commutator are connected to the corresponding first, second and third output of the target seeker, while the third inputs to the corresponding fourth, fifth and sixth output of the second target seeker. The first and the second output of the target seeker serve, at the same time, as the third and the fourth output of the guidance device. Besides, the second inputs of the abovementioned commutators are paralleled with the second inputs of the tenth and the eleventh commutator and serve as the commutation input of the guidance device, while the outputs of the fifth, sixth and seventh commutator are connected respectively to the first, second and third input of the second search signal conditioner, whose first and second output are connected respectively to the third inputs of the eighth and the ninth

commutator. The second inputs of these commutators are paralleled and connected to the third output of the second search signal conditioner, with the first inputs of the eighth and the ninth commutator connected respectively to the outputs of the tenth and the eleventh commutator, the first inputs of which are connected to the first and the second output of the second target seeker, while their third inputs are connected respectively to its fourth and the fifth output.

**Item 5.** The system for lighting of an object in accordance with Item 4 distinguished by the following: a laser installed in the third guidance device serves a source of radiation. The laser is connected to the laser excitation circuit, the first and the second input of which are connected to the third and the fourth output of the third guidance device.

**Item 6.** The system for lighting of an object in accordance with Item 5 distinguished by the following: the laser excitation circuit includes the second radio receiver, a remote switch, connected to the second source of the unit signal, and connected in series the second element "I", an inverter and the third element "$I_8$", the second input of which is connected through the remote switch to the source of unit voltage, while its output is at the same time the output of the third "I" element. Besides, the first and the second input of the second "I" element serve at the same time as inputs of the excitation system and are connected respectively to the third and the fourth output of the third guidance system.

**Item 7.** The system for lighting of an object in accordance with Item 3 distinguished by the following: the search signal conditioner includes a logical unit, the output of which is connected to the reset input of a linearly changing generator and to the paralleled record permitting inputs of the first and the second storage sampling device. The outputs and information inputs of the storage sampling devices are connected respectively to the first inputs and outputs of the first and the second summer; the second inputs of the summers are connected respectively to the outputs of the first and the second modulators, whose first inputs are paralleled and connected to the output of the linearly changing voltage generator. The second

inputs of the dfirst and the second modulators are connected respectively to the first and second output of the quadrature oscillator. Besides, outputs of the first and the second summer are connected respectively to the inputs of the first and second analog-to-digital converter, while inputs and the output of the logical unit together with outputs of the analog-to-digital converters are respectively the inputs and outputs of the controlling signal conditioner.

**Item 8.** The system for lighting of an object in accordance with Item 1, Item 2, and Item 7 distinguished by the following: the first guidance device, optically bound with an object, is equipped with the first target seeker kinematically attached through the first and the second bracket to the fifth and the sixth actuators and respectively to the first and the second angular position pickup. The second guidance device, optically bound with the source of radiation, includes the second target seeker, kinematically attached through the third and the fourth bracket with the seventh and the eighth actuators and the third and the fourth angular position pickup. The first mirror kinematically attached to the first actuators is fixed on the internal frame of the first gimbal mount, the external frame of which is kinematically attached to the second actuators. The system also includes the second gimbal mount, which consists of the internal and external frame kinematically bound respectively to the third and the fourth actuators. The external frame of the second gimbal mount is joined to the concentric ring, on which the second mirror is fixed.

**Item 9.** The system for lighting of an object in accordance with Item 1distinguished by the following: the second mirror is made in the form of two rings concentric on the outer ring of the gimbal mount and on the attached to it the internal and external pneumatic chamber pneumatically joined by radial tubes to each other and to the source of compressed gas (air). The pneumatic chambers and the radial tubes are connected with a reflecting sheet, which consists of an elastic dielectric film, coated with a light reflecting metal cover (e.g., aluminium).

**Item 10.** The system for lighting of an object in accordance with Item 9 distinguished by the following: the second mirror has an additional second reflecting sheet, which is adjusted at a fixed distance from the first one, with the metal layers of the sheets connected to the opposite poles of the re-introduced **emf** source.

**Item 11.** The system for lighting of an object in accordance with Item 9 distinguished by the following: the first and the second reflecting sheet together with the internal and external pneumatic chamber create a hermetically sealed cavity of reduced pressure attached to a re-introduced source of vacuum.

**Item 12.** The system for lighting of an object in accordance with Item 10 distinguished by the following: the internal pneumatic chamber consists of two pneumatically integrated sections joined by a corrugated elastic band in order they could move relative to each other. The metal coating of the second reflecting sheet is made in the form of concentric rings isolated from each other and connected to different controlled voltage sources.

~~The abstract~~ Replace with Insert C, attached

~~The invention deals with navigational engineering, specifically, optical-electronic systems for autotracking of moving objects~~.

The p~~urpose of the presentational invention consists in diversifying function~~s of ~~a target seeker by enabling it to search for a ground target and to light it from~~ the o~~uter space~~.

The i~~mplementation of this invention will technically result in more preci~~se measurin~~g of angular coordinates of the target because now the beam is pointed~~ at ~~the centre of the target image.~~

This t~~echnical result is achieved owing to some elements installed in the first~~ de~~vice of the object guidance, such as an additional second guidance device~~ op~~tically connected with the radiation source, the first and the second subtracting~~ am~~plifier, the first and the second actuator and a mirror. The first outputs of the~~ first ~~and the second guidance device are connected to the corresponding inputs of~~ the ~~first subtracting amplifier, while the second outputs — to the corresponding~~ in~~puts of the second subtra~~cting ~~amplifier. The outputs of the first and the second~~ sub~~tracting amplifier~~ ~~are connected to the inputs of the corresponding actuators~~ kinematically linked to the mirror.

The co~~mmutation unit includes the first and the second commutator, a radio~~ rece~~iver, a three-contact four-position radio-controlled switch, a source of un~~it vo~~ltage, an "I" element, an inverter and a radio transmitter — all appropriate~~ly conne~~cted to each oth~~er.

The first ~~and the third guidance device is of identical circuit design and~~ act~~uates electrically linked to each other the target seeker (TS), the search signal~~ cond~~itioner (SSC), the first~~ ~~and the second angular position pickup~~ ~~($APP_1$, $APP_2$~~), commutators~~, the third and the fourth actuators ($A_3$, $A_4$), kinematically linked with~~ a ~~target seeker, and the angular position pickups~~.

The sec~~ond guidance device has a target seeker equipped with a light mark~~er (or a ~~corner reflector), the fifth and the sixth actuators, the first and the se~~cond angular ~~position pickup, whose outputs are at the same time the first and the seco~~nd outpu~~t of the guidance device, the third - ninth commutators and a search sig~~nal cond~~itioner with the corresponding connections.~~

The l~~aser excitation circuit includes the second radio receiver, a remo~~te switch, co~~nnected to the second source of a unit signal, and connected in series~~ the seco~~nd element "I", an inverter and the third element "I", the second input of whi~~ch is ~~connected through the remote switch to the source of unit voltage, while it~~s output~~ is at the same time an output of the third "I" element. Besides, the first and~~ the s~~econd input of the first "I" element serve at the same time as inputs of the~~ exci~~tation system, which are connected to the third and the fourth output of~~ the t~~hird guidance system~~.

The~~ mirror is made in the form of two rings concentric on the outer ring~~ of the gimba~~l mount and on the attached internal and external pneumatic chamb~~er pneum~~atically joined by radial tubes to each other and to the source of compress~~ed gas~~ (air). The pneumatic chambers and the radial tubes are connected with~~ a refl~~ecting sheet, which consists of an elastic dielectric film, coated by a light~~ refl~~ecting metal cover (e.g., aluminium~~).

In the~~ second variant, the mirror has an additional second reflecting sheet~~, which ~~is adjusted at a fixed distance from the first one, with the metal layers of~~ the sheets~~ connected to the opposite poles of the re-introduced emf sourc~~e.

The ~~internal pneumatic chamber consists of two pneumatically integrated~~ sect~~ions joined by a corrugated elastic band in order they could move relative~~ to ea~~ch other. The metal coating of the second reflecting sheet is made in the form of~~ concent~~ric rings isolated from each other and connected to different controll~~ed v~~oltage sources.~~

— Description~~: 33 pages, 10 figures, and 12 dependent items of the invention~~.

INSERT C

## ABSTRACT OF THE DISCLOSURE

A system for lighting an object has a radiation source, a first guidance device optically connected to the object, a second guidance device and a first subtracting amplifier in communication with the first guidance device. The first subtracting amplifier has inputs and at least one output. A second subtracting amplifier is in communication with the first and second guidance devices. A commutation unit is in communication with the first and second guidance devices and the first and second subtracting amplifiers. First, second, third and fourth actuators are in communication with the commutation unit. A first mirror is in communication with and controlled by the first and second actuators and a second mirror is in communication with and controlled by the third and fourth actuators. The first and said second mirrors are controlled by the actuators so that the system can light an object by reflecting the radiation source.

R:\Patents\A\ALIEV ET AL\replacement abstract.wpd